(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 626 238 A1**

(12) # EUROPEAN PATENT APPLICATION

(21) Application number: **94303642.6**

(51) Int. Cl.^{5}: **B24D 11/06**, B24D 11/00

(22) Date of filing: **20.05.94**

(30) Priority: **20.05.93 GB 9310398**

(43) Date of publication of application:
30.11.94 Bulletin 94/48

(84) Designated Contracting States:
DE ES FR GB IT

(71) Applicant: **MINNESOTA MINING AND MANUFACTURING COMPANY**
3M Center,
P.O. Box 33427
St. Paul, Minnesota 55133-3427 (US)

(72) Inventor: **Ennis, Mark R. c/o 3M United Kingdom PLC**
Interface Development Ltd.
Horns Road
Hawkhurst
Kent TN18 4QT (GB)
Inventor: **Burgess, Robert M. c/o 3M United Kingdom PLC**
Interface Development Ltd.
Horns Road
Hawkhurst Kent TN 18 4QT (GB)

(74) Representative: **Bowman, Paul Alan et al**
LLOYD WISE, TREGEAR & CO.
Norman House
105-109 Strand
London WC2R OAE (GB)

(54) **Process for the manufacture of endless coated abrasive articles.**

(57) A method for making a spirally wound, endless coated abrasive belt is disclosed.

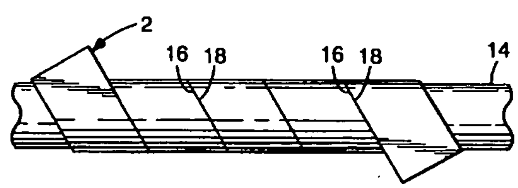

Fig. 2

Jouve, 18, rue Saint-Denis, 75001 PARIS

This invention relates to endless coated abrasive articles and to their method of manufacture. In particular, the invention relates to spiral wound abrasive belts.

Endless coated abrasive articles, such as belts, sleeves, tubes and the like, are used in a variety of abrading operations thus requiring that they be made and supplied by the coated abrasive manufacturer in a large variety of widths and circumferences.

Coated abrasive belts in most instances are only as wide as the coated abrasive material from which they are manufactured. In the manufacture of these belts, a piece of coated abrasive material, equal in width to the desired belt width, is cut at a suitable angle to its longitudinal direction. In a direction lengthwise, a length equal to the desired belt circumference plus an allowance for forming a lap joint, if such a joint is to be formed, is measured off. A second cut is then made at the same angle as the first. To at least one of the cut ends, after skiving, adhesive composition is applied and the ends are then joined by overlapping and are caused to adhere to one another by means well known to those skilled in the art. Alternatively, the piece of coated abrasive material may be cut to length without the allowance for overlap and the cut ends are butted and joined to one another with an overlapping reinforcing flexible patch suitably adhered to the backside of the two ends of the abrasive material.

EP-A-0497451 discloses a further method of making an endless abrasive belt comprising an abrasive layer supported on a flexible backing material, which flexible backing material comprises a flexible support and a layer of hot-melt adhesive, the method comprising the steps of:

(a) forming complementary ends on an elongate strip of said flexible backing material,

(b) placing said complementary ends in abutting engagement,

(c) applying pressure and heat over the area of the abutting ends sufficient to cause the hot-melt adhesive to flow across the abutment, and

(d) allowing said area to cool whereby the hot-melt adhesive forms a continuous layer over the abutting ends,

the layer of hot-melt adhesive having sufficient strength to maintain the integrity of the belt.

This process of abrasive belt manufacture, as one can readily observe, is limited in the maximum width of endless belt that can be manufactured to the maximum width of available coated abrasive material. Various attempts, as hereinafter more fully discussed, have been made to provide coated abrasive belts of a width greater than the width of conventionally available coated abrasive material.

According to one such above mentioned methods of manufacture of wider belts, a piece of coated abrasive material of suitable width is cut zit an angle to the length direction, as before. In a direction perpendicular to the cut edge the desired width of the belt is measured off and a second cut is made at the same angle as the first. A second piece is cut congruent with the first and the two pieces are joined along edges parallel with the length direction of the original coated abrasive material, either by forming an overlapping joint or by forming a reinforced butt joint in the manner previously described. By proper choice of width of coated abrasive material, angle of the cut with respect to the length direction of the coated abrasive material and number of congruent pieces selected, wide, multiple join sectional belts covering a broad range of belt widths and belt circumferences can be fabricated. However, the necessity of fabricating multiple joints makes the manufacture of these sectional belts a relatively expensive process. Moreover, each additional joint in a belt is a potential additional source of belt weakening and a potential additional source of problem with process control and quality of workmanship.

Another method of manufacture of wider belts is the patterned section construction disclosed in Canadian Patent No. 560413. The patent discloses a method of manufacture of both sectional belts and single joint belts, each having maximum strength and minimum stretch in its circumferential direction from a coated abrasive material having a relatively high strength and low stretch in one direction and a relatively low strength and high stretch in the perpendicular direction. Belts made according to this invention, however, have a large number of expensive joints and substantial waste is experienced in cutting the component parts to the required shapes.

Other methods of manufacture of endless wider belts and the like are also known. One such method involves winding an inner liner spirally on a mandrel having an outer circumference equal to the inside circumference of the desired abrasive belt, applying an adhesive to the outer surface of the inner liner, and winding spirally over the adhesive layer a strip of coated abrasive material. Such a method is widely used for the fabrication of belts in smaller sizes, up to, for example, 6 inches in diameter or 19 inches in circumference.

Another method of manufacture of endless coated abrasive articles involving spiral winding is disclosed in Swiss Patent No. 390717. An abrasive article of spiral configuration in which the edges abut one another is disclosed. The joint thus formed is bridged with a metal band or thin synthetic resin film. A spiral wound abrasive belt of slightly different configuration is disclosed in U.S. Patent No. 2,189,754. The joint in the belt therein disclosed has overlapping bevelled edges.

U.S. Patent No. 4,018,574 discloses a process for the manufacture of an endless coated abrasive article comprising the following steps:

a) cutting a coated abrasive material at a first lo-

cation along the longitudinal edge at an angle to the length direction thereof such that the length of the cut edge is equal to the circumference of the article to be fabricated.

b) cutting said material at a second location along said longitudinal edge and at a predetermined distance from said first location so as to provide a second cut edge parallel to said first cut edge thereby forming a strip of abrasive material having the shape of a parallelogram,

c) winding said strip of abrasive into a spiral comprising a plurality of coils having the abrasive surface on the outside of said coils whereby said longitudinal edge is in abutting engagement with the other longitudinal edge of the parallelogram, said spiralled abrasive strip having an inner and outer periphery,

d) rotating said spiralled abrasive strip about its own axis while said strip is rotating,

e) applying to said inner periphery smooth, uniformly thick, a resinous composition whereby said composition forms a continuous layer on the inner periphery of the coiled strip of abrasive material, and

f) curing said resinous composition thereby providing an endless coated abrasive article of unitary construction and of greater width than said strip of abrasive material.

The above described methods do not find practical utility in the production of abrasive belts of small diameter. Such belts are often referred to as bands and are generally placed over a single drum or wheel in use, so that the whole of the inside of the band is in contact with the outside of the drum or wheel, rather than being supported over two or more pulleys or rollers like the larger abrasive belts. The bands often have a diameter of 60mm or less and a width less than 50mm and are generally employed for abrading/polishing cut-outs in materials or inside articles e.g. abrading interior welds in tubes or other fabrications.

The small dimensions of such bands does not readily allow the use of some of the known methods for the production of abrasive belts. Other techniques e.g. formation of end to end butt joints, are difficult to practice with such small materials.

The present invention provides an alternative process for the manufacture of an endless coated abrasive article which is particularly suitable for the manufacture of bands.

According to the present invention there is provided a method of making an endless abrasive belt comprises the steps of:

a) providing a strip of abrasive material comprising an abrasive layer bonded to a flexible backing material, which flexible backing material comprises a flexible support and a layer of hot-melt adhesive,

b) winding the strip of abrasive material around a mandrel in a spiral configuration such that the edges of the strip of adjacent turns of the spiral are in abutting engagement,

c) maintaining said spiral configuration and heating the strip of abrasive material to a temperature sufficient to cause the hot-melt adhesive to flow across the abutted edges,

d) maintaining said spiral configuration and allowing the strip of abrasive material to cool whereby the hot-melt adhesive forms a continuous layer over the abutted edges and the strip of abrasive material is bonded to form a tube, and, where necessary

e) converting the tube from step d) to form one or more endless abrasive belts.

The invention provides a simple and effective method of preparing an endless abrasive belt of substantially uniform thickness by butt joining the edges of a spirally wound elongate strip of abrasive material without the use of reinforcing patches or the like. The invention utilizes a flexible support in conjunction with a layer of hot-melt adhesive which is caused to form a continuous layer within the region of the butt joint and possesses sufficient strength to ensure the integrity of the belt during its use.

Abrasive belts formed with such a joint run evenly, equally well in either direction and are found to have a good working life. The joint is easily fabricated and lends itself to the use of automated machinery. Moreover, as the joint has substantially the same thickness, density and flexibility as the remainder of the belt, abrasive belts incorporating such a joint are less prone to premature wear in the joint region, thereby avoiding the problem of marking the workpiece, and they do not "bump" or "chatter" during use.

The simple manufacturing technique may readily be used for the production of bands. An abrasive strip may readily be spirally wound round a mandrel of small diameter and, after heating and cooling, forms a dimensionally stable abrasive tube. The abrasive tube could be used directly as a belt or band if it is of the desired dimensions. However, normally the abrasive tube will be converted into one or more bands by cutting or trimming etc. Typically an abrasive tube will be converted into a plurality of bands e.g. 4 or more.

The coated abrasive belt may be in any conventional form including those having an abrasive layer comprising a make layer, abrasive granules or particles, a size layer, etc., and other functional layers (e.g., a supersize layer), and those having a monolayer as an abrasive layer comprising a slurry layer comprising a bond system and abrasive grain, and other functional layers. Preferably, the abrasive layer comprises a mesh material onto which is electroplated a layer of a metal, into which are embedded abrasive granules or particles.

The backing may further comprise at least one of a presize (i.e., a barrier coat overlying the major sur-

face of the backing onto which the abrasive layer is applied), a backsize (i.e., a barrier coat overlying the major surface of the backing opposite the major surface onto which the abrasive layer is applied), and a saturant (i.e., a barrier coat that is coated on all exposed surfaces of the backing). Preferably; the backing material comprises a presize. Suitable presize, backsize, or saturant materials are known in the art. Such materials include, for example, resin or polymer lattices, neoprene rubber, butylacrylate, styrol, starch, hide glue, and combinations thereof.

With the exception of the backing material and the method of forming the band, a coated abrasive belt according to the present invention can be prepared using materials and techniques known in the art for constructing coated abrasive articles.

The preferred bond system (i.e. slurry coat or make coat and size coat) is a resinous or glutinous adhesive. Examples of typical resinous adhesives include phenolic resins, urea-formaldehyde resins, melamine-formaldehyde resin, epoxy resins, acrylate resins, urethane resins, and combinations thereof. The bond system may contain other additives which are well known in the art, such as, for example, grinding aids, plasticisers, fillers, coupling agents, wetting agents, dyes, and pigments.

Examples of useful materials which may be used in the supersize coat include the metal salts of fatty acids, urea-formaldehyde, novalak phenolic resins, waxes, mineral oils, and fluorochemicals. The preferred supersize is a metal salt of a fatty acid such as, for example, zinc stearate.

In the first preferred conventional method for preparing a coated abrasive article, a make coat is applied to a major surface of the backing following by projecting a plurality of abrasive granules into the make coat. It is preferable in preparing the coated abrasive that the abrasive granules be electrostatically coated. The make coating is cured in a manner sufficient to at least partially solidify it such that a size coat can be applied over the abrasive granules. Next, the size coat is applied over the abrasive granules and the make coat. Finally, the make and size coats are fully cured. Optionally, a supersize coat can be applied over the size coat and cured.

In the second preferred conventional method for preparing a coated abrasive article, a slurry containing abrasive granules dispersed in a bond material is applied to a major surface of the backing. The bond material is then cured. Optionally, a supersize coat can be applied over the slurry coat and cured.

In the above methods, the make coat and size coat or slurry coat can be solidified or cured by means known in the art, including, for example, heat or radiation energy.

For an abrasive layer comprising a layer of a mesh material onto which is electrodeposited a layer of metal (e.g., nickel), into which are embedded abrasive granules, the coated mesh material is typically laminated onto a major surface of the backing material- or alternatively, in the case of a single layer backing onto the adhesive layer.

The preparation of suitable electrodeposited abrasive layers is known in the art and disclosed, for example, in U.S. Patent No. 4,256,467, British Patent No. 2200920 and European Patent No. 13486. Generally, the abrasive layer is formed by laying a length of mesh material onto an electrically conducting surface and electrodepositing a metal onto the mesh material in the presence of abrasive granules such that the abrasive granules become embedded in the metal. If a pattern of abrasive granules is desired, an insulating material is selectively applied to the mesh material before deposition of the metal layer so that the metal can only deposit onto the mesh in those areas not covered by the insulating material, thereby defining the pattern of the abrading surface.

In one method of making an electrodeposited abrasive layer, a mesh material in the form of a woven fabric of electrically insulating material such as nylon, cotton or terylene is screen printed with an ink comprising an insulating material, wherein the ink is compatible with any hot-melt adhesive which may subsequently be applied to the abrasive layer to secure it to the backing material. Preferably, the ink is resin based or oil based ink. The ink may be coloured as desired. Typically, the insulating material is waterproof and acid resistant. Preferably, the insulating material is colour fast at elevated working temperatures of the abrasive article (e.g. up to about 220°C).

Conventional screen printing techniques may be used to print the ink onto the mesh. If a pattern of abrasive granules is desired, the screen printing technique used must ensure that the ink penetrates into and is absorbed onto defined areas of the mesh material such that discrete areas with and without ink are provided. Such discrete areas may be of any convenient shape and size, including, for example, circles, diamonds, squares, rectangles, etc.

The abrasive layer comprising the mesh material can be adhered to the backing material by applying a layer of adhesive to either the abrasive layer or the backing material. The adhesive material is then cured, or in the case of a hot-melt adhesive, heated and then cooled. Preferably, the adhesive is acid resistant and water repellent. Suitable adhesives include, for example, that marketed under the trade name BOSTICK 3206 available from Bostick Limited of Leicester, United Kingdom.

In another method, the ink may be combined with an adhesive and screen printed onto the mesh material. The metal and abrasive is deposited, as described above, and the resulting abrasive layer may be applied to the backing material and the adhesive material cured, or in the case of a hot-melt adhesive, heated and then cooled. Preferably, the adhesive is

acid resistant and water repellant.

In another method, instead of the insulating material being an ink or an ink and an adhesive, a hot-melt adhesive only is used as the insulating material. Preferably, the hot-melt adhesive is acid resistant and water repellent. The hot-melt adhesive may be, for example, a sheet which is applied to the mesh material before electrodeposition. Typically, the adhesive sheet has a plurality of openings of desired shape and size. The hot-melt adhesive sheet is placed in contact with the mesh material and heated while applying sufficient pressure to cause the adhesive to absorb and enter the spaces of the mesh material. When the mesh material is fully penetrated the resulting composite is cooled. The mesh material is then electrodeposited with metal and abrasive as described above. The resulting abrasive layer has adhesive on both sides of the mesh material, and surrounding the metal areas. The abrasive layer can be readily adhered to the backing material by applying sufficient heat through the surface of the backing material opposite that onto which the abrasive layer is to cause the adhesive to adhere the mesh material to the backing material.

The flexible supports of the backing material may comprise any suitable material known in the art including both woven and non-woven webs, papers, fabrics and cloths and polymeric films. The flexible supports preferably comprise a web of a woven material.

The hot-melt adhesive is selected so that the melting temperature of the adhesive is above the operating temperature of the abrasive belt. For high temperature applications the hot-melt adhesive should have a melting point at or above 220°C, while for lower temperature applications, the melting point may be as low as 120°C. Polyurethane based adhesives are found to be particularly suitable for use in the present invention. The adhesive serves the functions of bonding the support layers together when the backing material comprises two support layers and in bonding the edges of the backing material together at the joint formed when assembling the belt.

The backing material preferably comprises two flexible support layers sandwiching a layer of a hot melt adhesive. The backing material generally has a thickness in the range 0.5 to 2.5mm, preferably 1.0 to 1.5mm with a typical value of about 1.3mm and a weight of from 0.5 to 2.5 kg/m^2, preferably 0.75 to 1.5 kg/m^2 with a typical value of about 1.15 kg/m^2.

A preferred backing material is commercially available from Charles Walker & Co. Ltd., under the trade name BETALON TC13/NM and comprises two woven polyester/cotton sheets with a layer of a polyurethane hot-melt adhesive therebetween.

The abrasive mineral may be of any particle size and any type useful for coated abrasive belts including flint, cork, vermiculite, quartz, garnet, silicon carbide, diamond, cubic boron nitride, boron carbide, alumina, including fused alumina, heat treated versions and ceramic alumina (e.g. sol-gel derived alumina), fused aluminazirconia and combinations thereof.

The invention will now be described by way of example with reference to the accompanying drawings in which:

Figure 1 represents a cross-section through an abrasive strip suitable for use in the invention, and

Figure 2 represents schematic illustration of the manufacture of an abrasive belt in accordance with the invention.

Figure 1 shows an abrasive strip (2) comprising a flexible backing material (4) having a major surface bearing a layer of abrasive material (12). The backing material is formed from flexible supports (6 and 8) and a layer of hot-melt adhesive (10) which is parallel to the major surface of the backing material. Only one flexible support need be present but two flexible supports are preferred for strength and stability.

The layer (12) of abrasive material may comprise particles of abrasive mineral or grit embedded in one or more resin layers, or it comprises a layer of a mesh material onto which is electrodeposited a layer of a metal, e.g., nickel, into which are embedded particles of abrasive mineral. The coated mesh material is simply laminated onto the upper flexible support (6) of the support material (4), or alternatively, in the case of a single layer backing, the adhesive layer (10).

Figure 2 shows the strip of abrasive material (2) spirally wound on a mandrel (14). In order to maintain the spiral configuration, one end of the strip (2) may be secured to the mandrel with a pressure sensitive adhesive tape (not shown). The mandrel (14) is then rotated e.g. on a lathe etc., while guiding the strip material (2) such that the edges (16, 18) of adjacent turns abut. After ensuring the strip (2) is tightly wound the free end is then secured to the mandrel with pressure-sensitive adhesive tape. If desired, the spiral but joints may be covered e.g. with pressure sensitive adhesive tape such as a tape commercially available from Minnesota Mining and Manufacturing Company under the trade name Green-tape No. 850, to prevent hot-melt adhesive flowing from the joint onto the abrasive layer.

The abrasive strip is heated to a temperature sufficient to melt the adhesive in the region immediately adjacent to the line of abutment and the pressure of the wound strip causes the melted adhesive to flow across the joint between each edge (16, 18). The strip is then cooled while continuing to maintain the spiral configuration so that the adhesive forms a continuous film or layer across the joint. This gives a strong joint having no significant variation in its thickness or flexibility when compared with the remainder of the belt. An abrasive belt formed in this manner has a good ac-

tion and working life.

The heating stage may be accomplished by placing the mandrel in an oven or by means of a heating element positioned within the mandrel. The temperature and heating time depend upon the particular adhesive employed, a typical temperature is about 180°C for a period of from 10 to 20 minutes.

The invention is particularly applicable to even-run bands which are intended to be used over drums or wheels. Such bands have relatively small diameters, e.g., 15, 22, 25, 30, 45, 50 and 60mm, which are not readily fabricated by employing an end to end splicing technique. The invention readily allows production of a tube of abrasive material from which several of such bands may be cut. The width of the strip of abrasive material is generally similar to the diameter of the mandrel. The width of the bands is preferably less than 50mm and generally ranges from 20 to 42mm.

Claims

1. A method of making an endless abrasive belt comprises the steps of:
   a) providing a strip of abrasive material comprising an abrasive layer bonded to a flexible backing material, which flexible backing material comprises a flexible support and a layer of hot-melt adhesive,
   b) winding the strip of abrasive material around a mandrel in a spiral configuration such that the edges of the strip of adjacent turns of the.spiral are in abutting engagement,
   c) maintaining said spiral configuration and heating the strip of abrasive material to a temperature sufficient to cause the hot-melt adhesive to flow across the abutted edges,
   d) maintaining said spiral configuration and allowing the strip of abrasive material to cool. whereby the hot-melt adhesive forms a continuous layer over the abutted edges and the strip of abrasive material is bonded to form a tube, and, optionally
   e) converting the tube from step d) to form one or more endless abrasive belts.

2. A method as claimed in claim 1 in which the flexible backing material comprises two flexible support layers with the layer of hot-melt adhesive between said support layers.

3. A method as claimed in claim 1 or claim 2 in which the flexible support layer(s) comprise(s) woven webs.

4. A method as claimed in any preceding claim in which the hot-melt adhesive has a melting point of at least 120°C.

5. A method as claimed in claim 4 in which the hot-melt adhesive has a melting point of at least 220°C.

6. A method as claimed in any preceding claim in which the hot-melt adhesive is a polyurethane adhesive.

7. A method as claimed in any preceding claim in which each end of the abrasive strip is secured to the mandrel by adhesive tape to maintain the spiral configuration.

8. A method as claimed in any preceding claim in which the mandrel has a diameter of not more than 60mm.

9. A method as claimed in any preceding claim in which the width of the abrasive strip is about the same as the diameter of the mandrel.

10. A method as claimed in any preceding claim in which the abutting edges are covered with adhesive tape prior to the heating and the adhesive tape is removed after cooling.

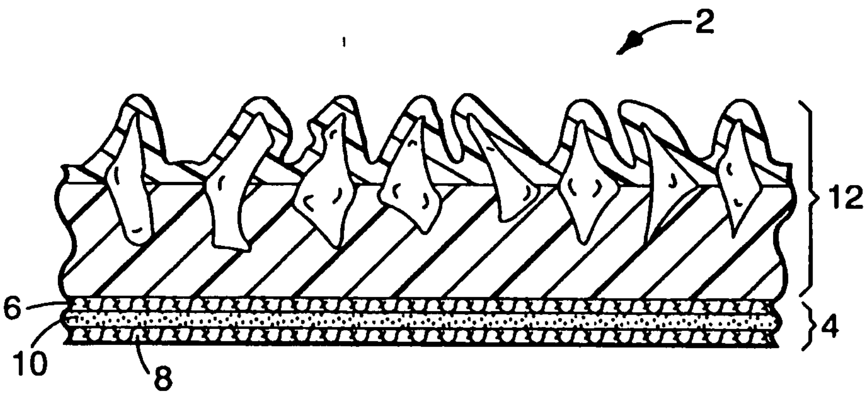

Fig. 1

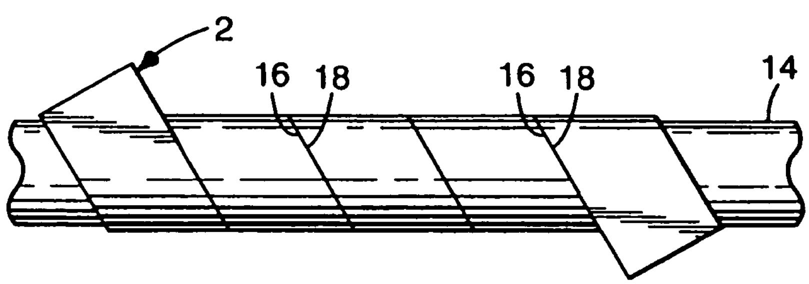

Fig. 2

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 94 30 3642

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.5)
Y	US-A-4 039 303 (YASUSHI ET AL.) * column 2, line 56 - column 4, line 62; figures *	1-5,8	B24D11/06 B24D11/00
D,Y	EP-A-0 497 451 (3 M CO.) * column 4, line 17 - line 53; figure 1 *	1-5,8	
A	FR-A-2 250 049 (THE CARBORUNDUM CO.) * claims 10-13 *	6	

TECHNICAL FIELDS SEARCHED (Int.Cl.5)

B24D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	9 September 1994	Eschbach, D

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)